A New Cyclotron Maser Mechanism Observations and Theory

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We present a new cyclotron maser type instability driven by a crescent or horseshaped electron distribution function. Such distribution functions are easily created by an electron beam moving into a stronger magnetic field region, where conservation of the first adiabatic invariant causes an increase in their pitch angle. This produces a broad region on the distribution function where there is a +ve slope in the perpendicular component of the velocity space distribution function. Planetary dipole magnetic fields are examples of where these types of distributions can be found, giving rise for example to the earth's auroral kilometric radiation and Jupiter's decametric radiation signatures.

We examine the stability of these electron horseshoe distribution functions for right-hand extraordinary mode (R – X mode) radiation close to the electron cyclotron frequency propagating perpendicular to the magnetic field using both non-relativistic and relativistic beams. A quasi-linear theory is developed which is used to analyze the saturation process. Saturation occurs when the perpendicular slope in velocity space forms a plateau. This provides an estimate of the efficiency of such a process. Calculations suggest that efficiencies as high as 20% can be achieved. Finally, a laboratory experiment to investigate this new type of instability will be discussed.